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Drinking Water's Quality Perception and the related Consumption Practices in Niamey (Niger)

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Abstract

The management of drinking water quality is a key factor for the prevention and control of waterborne diseases and the judgment on water quality is a matter on which the public can play an important role. In Niger, studies on drinking water are limited without addressing water consumption practices. This study analyzes the quality perception and consumption frequency of different kinds of drinking water by some consumers in Niamey. Interviews with 211 persons showed that tap water is consumed the most daily (91.46%) ahead of sachet water (04.26%) and bottled water (02.36%). Sachet water is the most occasionally consumed drinking water (65.87%) ahead of bottled water (18.00%) and other types of water. Daily consumption varies from 1.5 to more than 7 liters of water. The judgment made on tap water as to its quality is rather acceptable according to 45.02% of those interviewed. The quality of the bagged water is also considered acceptable by 50.23% of these consumers. More than half of these consumers, 52.00%, rated the bottled water of good quality, while 09.47% rated it as very good and 04.26% rated it as excellent. These results illustrate the water consumption practices in the city of Niamey.

Keywords: bottled water, Niamey, sachet water, tap water, quality perception,

Introduction

Although the requirements for the quality of drinking water are becoming more and more stringent, consumers are increasingly concerned about the safety of public drinking water (Euzen 2005). Studies around the world have shown frequent use of alternative water sources due to the public's perception of the risk to tap water (Jones *et al*. 2007; De Queiroz *et al*., 2013; Leal *et al*. 2015). In addition, the availability of water, the price, the management of drinking water services, climatic conditions are the factors that influence drinking water consumption practices in developing countries. (Bakobi *et al*., 2017; Ohwo and Agsomu 2018). This leads to spatial variability in the perception of the quality and choice of drinking water.

In urban areas, tap water and packaged water remain the most consumed in both industrialized and developing countries. The management of the quality of tap water is a key factor for the prevention and control of water-borne diseases and, moreover, the judgment on the quality of the water is a matter in which the public can play an important role (Doria 2010). Consumer surveys provide essential information on the public's perception of water quality (Doria 2010; Abdi-Soojeede and Kullane 2019).

Thus, numerous studies in sub-Saharan Africa as well as in several countries of the world have studied the public's perception of the tap water quality and the factors that encourage households to consume packaged water (Montginoul and Waechter 2007; Cheabou and Ephraim 2014; Miner *et al*. 2015; Odjegba *et al*. 2015; Jalloh *et al*. 2018; Ohwo and Agsomu 2018). In Niger, studies on drinking water are limited without addressing water consumption practices, particularly the consumed quantity of water, the preferred type of water, the assessment of its quality, etc. In addition, a study conducted by Doria (2010) shows that the perception of the quality of drinking water is largely influenced by taste, color, odor, habits and confidence. In addition to these studies, several other works have focused on the individual factors associated with the perception of water's quality. The factors identified mainly include organoleptic parameters, dissatisfaction with chemical parameters (hardness, chlorine, undefined chemical pollutants, nitrates), personal vulnerability, satisfaction with water services, information media, water availability and raw water source (Euzen 2005; Doria 2010; Garcia *et al*. 2018; Bakobi *et al*. 2017; Abdi-Soojeed and Kullane 2019).

As a result, consumers' appreciation of the organoleptic quality of water depends on each person's sensitivity to these parameters. In this sense, water with an unusual taste, odor or color can be appreciated negatively. In general, consumers' perception of water quality can be used as a decision-making aid. This study analyzes drinking water consumption practices in Niamey (Niger). More precisely, it concerns the perception of the quality, and the frequency of use of the different types of drinking water by some consumers.

Methodology

Study area presentation

The city of Niamey, Capital of the Niger Republic, is located in the southwestern of Niger between latitudes 13°35' and 13°24' South and longitudes 2°15' East. In 2017, the population of this city was estimated at 1,203,776 peoples and the city covers an area of 552.27 km^2 including 297.46 km^2 of urbanized area. The Niamey's region enjoys a Sahelo-Sudanese climate characterized by a short rainy season (from June to September) and a long dry season from October to May (INS 2018). Like major African cities, Niamey is facing strong demographic growth. The city's drinking water supply is mainly provided by water withdrawals from the Niger River. After treatment, the water reaches consumers through a distribution network. Water from boreholes, wells, bottled water and plastic bagged water (pure water) are also used for drinking.

Methods

A survey was conducted among 211 residents of the urban community of Niamey between June and October 2020. The aim is to collect information on their drinking water consumption practices. The survey covered both women and men over the age of 18; and is interested in:

- to the different categories of people according to their socio-professional activities: student, shopkeeper, civil servant, worker, craftsman, driver, etc.

- to the different households, taking into account the type of accommodation (house, room, apartment) occupied as well as the status of the occupants (owner, tenant, official accommodation).

Before each interview, the objective of the survey was presented to the respondents while guaranteeing the anonymity of the responses. Depending on the status (ability to speak in French or not) of these people, the interviews were carried out in French and / or in local languages. The various questionnaires concern the types of water, the consumed quantity of water per day, the quality perception, the water quality evolution and the treatment of water at home. Data was processed by Excel 2016 using percentages.

Results and Discussion

Respondants profile

Following the obtained results, table I shows the characteristics of the interviewed people. The 211 people to whom the interviews were administered are made up of 88 women, 41.71% and 123 men 58.29%. The age profile is made up of 14.21% of people aged from 18 to 25 years then, mainly 84.36% of those aged from 25 to 50 years and 01.42% of people over 50 years.

Table I : Consumers profile

Profile/consumers	*Effective*	*Percentage (%)*
	Respondants	
Men	*123*	*58.29*
Women	*88*	*41.71*
	Age profile	
< 25 years	*30*	*14.21*
25-50 years	*178*	*84.36*
> 50 years	*3*	*01.42*
	Instruction level	
Primary	*10*	*04.73*
Secondary	*99*	*46.91*
High school	*89*	*42.18*
None	*8*	*03.79*
Traditional islamic study	*5*	*02.36*
	Career	
Students	*112*	*53.08*
Traders	*21*	*09.95*
Civil servants	*27*	*12.79*
Others	*51*	*24.17*

In addition, 42.18% of these consumers have completed higher education, 46.91% have secondary education, 03.79% have not studied and very few of them have conducted the traditional islamic study (02.36%). Students represent 53.08% of interviewees; 09.95% are traders; 12.79% of civil servants. The rest 24.17%, is made up of workers, drivers, private security agents, butchers and the unemployed.

Daily consumption of drinking water in Niamey

The daily need for drinking water depends on the functions of the water and the mechanisms that regulate the daily water balance (Jéquier and Constant 2009). Thus, according to Jéquier and Constant (2009), a sedentary adult living in a temperate climate (that is, where temperatures are not extreme) should drink an average of 1.5 liters of water per day. Indeed, the intake of drinking water is useful in order to fight against dehydration. Because it can affect the state of consciousness and can induce disorders such as verbal inconsistency, general weakness, hypotonia of the eyeballs, orthostatic hypotension and tachycardia.

Figure 1 shows that 22.27% of 211 questioned people in Niamey announce that they consume 2 to 3 liters of water per day. This is the amount of water consumed by the largest group of respondents. Then, 18.48% of surveyed consumers consume an average of 4 to 5 liters of water while 06.16% consume more than 7 liters of water per day.

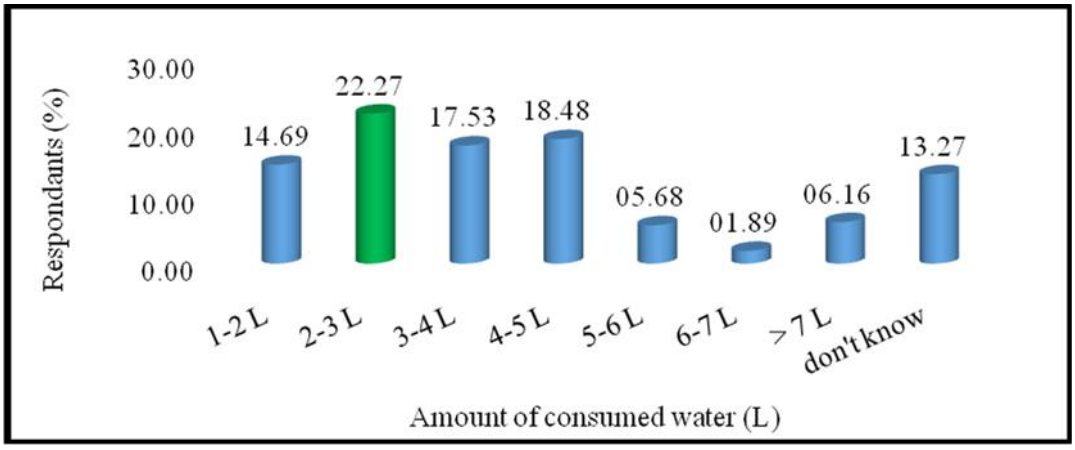

Figure 1: Daily amount of consumed water per person (L)

In general, the daily consumption therefore varies from 01.50 to more than 7 liters of water. The average volume is then estimated to be at least 4.50 liters if the maximum volume is limited to 7.50 liters of water. The daily consumption of 4.50 liters of water can be justified by a semi-desert climate where the temperature can range from 24 to 41 °C in the period of the survey. Physical activities and diet are also factors influencing the need for drinking water, which corresponds to about 75.00% of the total water need in the body. In addition, daily consumption is decreasing in other regions of the world. This is the case in Canada where Roche *et al*. (2012) reported the consumption of an average volume of 1.20 liters of water per day. On the other hand, 3.00 and 2.20 liters are the recommended total water intakes in the United States for men and women over 19, respectively. While in Europe, 1.75 and 1.40 liters of water are recommended for men and women over 19 years old respectively (Jéquier and Constant 2009). It should be noted that the daily consumption of drinking water and the recommended quantities are decreasing in other regions of the world compared to those of Niamey in sub-Saharan Africa.

Accessibility, the main reason for drinking tap water

Among the different types of consumed water in Niamey, tap water is the most regularly consumed. The percentage of regular consumers is 91.46% (Figure 2). The given reasons are mainly accessibility and low cost. However, very few consumers regularly drink sachet water, bottled water and borehole water with a percentage of 04.26; 02.36; and 01.89% respectively and never from the well water. These results are corroborated by those obtained by the National Institute of Statistics of Niger in 2015 which show that tap water is the main source of drinking water supply for 90.50% of households in Niamey (INS 2016).

Moreover, in the Strasbourg city (France) only 35.00% of the surveyed residents declared that they regularly drink tap water (Montginoul and Waechter 2007). This result shows that in France few people (one in three) drank tap water on a daily basis. In addition, a study recently conducted in Brazil by Garcia *et al*. (2018) shows that 93.00% of questioned consumers did not consume tap water due to a lack of confidence related to its taste and the perception of risk. Another similar study shows that 78.00% of a fringe of the population residing in Fortaleza (Brazil) did not consume tap water because of a risk perception (57.00%) and the inconvenience due to organoleptic parameters (21.00%) (Pestana *et al*. 2019).

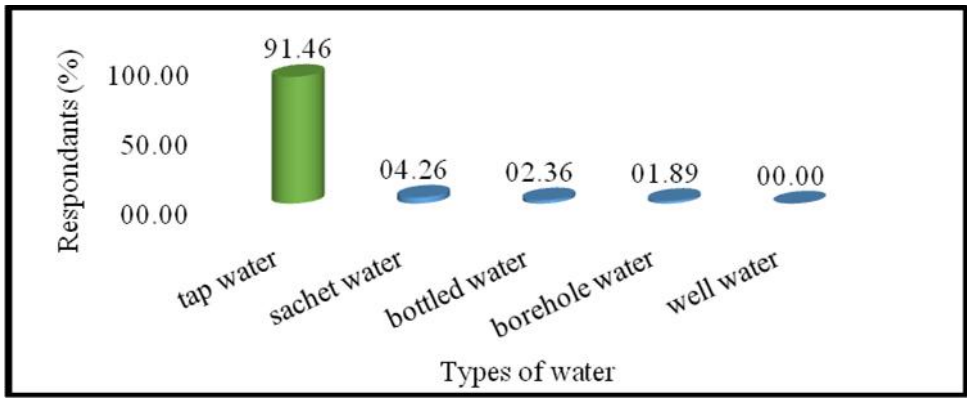

Figure 1 : *Type of water frequently consumed*

Freshness and ubiquity, reasons for drinking sachet water

Sachet bagged water is the most occasionally consumed by 65.87% of those interviewed (Figure 3). The reasons for choosing bagged water are above all its freshness, its ubiquity and also the constraints when moving or stopping tap water supplies. This percentage is higher than that obtained by Cheabou and Ephraim (2014) in Ghana who report that 22.00% of residents interviewed in Accra drank sachet water occasionally; of which 13.20% drank it only at home and 18.80% drank it in public. Bottled water comes after pure water as drinking water for occasional users who represent 18.00% of consumers. The reasons cited are above all the high cost, health reasons for the sick, vulnerability for newborns. In addition, some consumers say they occasionally drink tap water, borehole water and well water; their respective percentages are 09.95; 03.31 and 02.84%. While sachet water is consumed the most occasionally by respondents in Niamey, it was the main drink for interviewed consumers in Accra, Ghana in 2013 (Cheabou and Ephraim 2014).

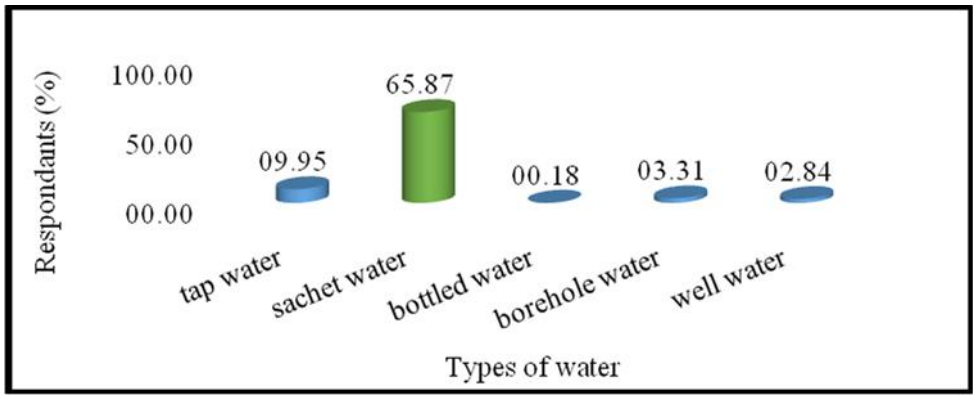

Figure 2 :*Type of water occasionally consumed*

Tap water's quality perception

The judgment made on tap water as to its quality is rather acceptable according to 45.02% of the people surveyed (Figure 4). This result is lower than that reported by Ohwo and Agsomu (2018) showing that the satisfaction index of served customers by tap water is 2.54/5, or 50.80%. That is, the quality of their tap water is considered acceptable. The result obtained is superior to that obtained by Odjegba *et al*. (2015) in the State of Ogun in Nigeria reporting dissatisfaction with tap water by 68.00% (therefore 32.00% satisfaction). Judging from its good quality, 36.96% of surveyed consumers in Niamey perceived the quality of their tap water to be good. This percentage is close to that obtained by Montginoul and Waechter (2007) who report that 35.00% of questioned people in the urban community of Strasbourg considered the tap water to be of good quality. But this percentage is lower than that obtained by Slabbert (2011) who reports that 81.00% of South African households surveyed perceived good water quality from their taps. However, none of the 211 water consumers in Niamey mentioned excellent quality and 14.66% of these consumers judged the tap water to be of poor quality. For its "good quality" the reasons given are mainly: no directly visible effect on health, its appearance, because "treated from raw surface water". For its quality considered fair, the reasons given are the observed deficiencies relating to its color and odor. The reasons for its poor quality are due to the odor of "drug", "iron", the color of "river water", rust, remains from the iron, lack of confidence.

In addition Sajjadi *et al*. (2016) also showed that in 2016 consumers in Iran expressed their dissatisfaction with tap water because of the bad taste (95.60%) and unacceptable appearance (27.80%). Thus, the perception of the quality of tap water is mainly assessed on the basis of its taste, odor and appearance. Indeed, the tastes and odors in the mains water can be due to the odor of chlorine, the growth of microorganisms, the emitted compounds by the piping and by the coatings of the tanks. Tastes and odors attributable to chlorine can be produced by chlorine compounds (Proulx *et al*. 2010). Chlorine is one of the most widely used disinfectants in drinking water. It is usually added to water in concentrations of 0.2 to 0.5 $mg.L^{-1}$ so that about 0.2 $mg.L^{-1}$ of residual chlorine remains in the water system. This residual chlorine can be in several forms; hypochlorous acid, hypochlorite ion or participate in the formation of chloramines or chlorophenols.

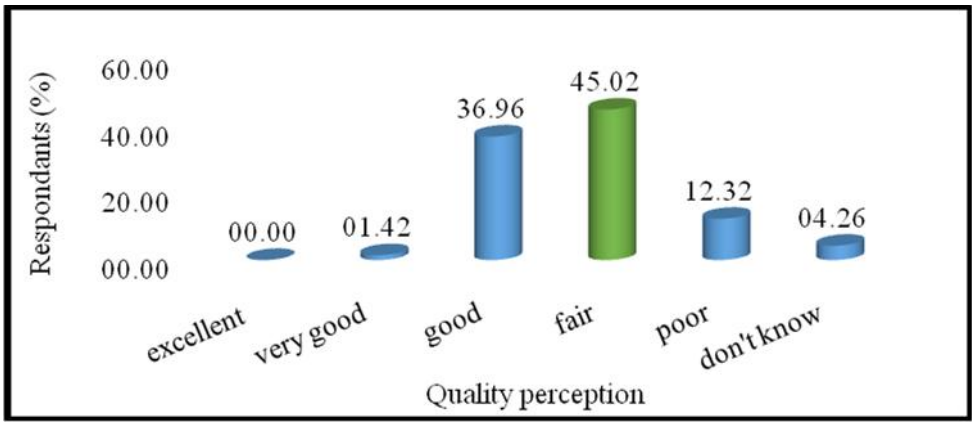

Figure 3 : Tap water's quality perception

Dealing with the perception of its poor quality, several householders believe that tap water cannot be considered safe for drinking as long as "metallic remains within it is observed". So over time "the pipe material damages" and the product of this degradation ends up in the distributed water. Some consumers support the same idea by stating that tap water is of doubtful quality, because not only does it take on an odor after stagnating for a few hours in the metal pipe, but also and above all it comes with "sandy particles" afterwards rain. Furthermore, it is noted that many consumers have qualified tap water as "dirty" because it always forms a deposit at the bottom of a storage container. Other consumers raised the issue of expatriates' refusal to consume tap water and prompted the question that why at a ceremony or workshop tap water is not used? This means, according to them, uncertain quality.

Although a change in color, a change in taste, or an odor release can be a sign of contamination of the water, the evaluation of the quality of water is not limited to a simple observation, tasting or a feeling of odor. Rather, it is based on the evaluation of a number of physical and chemical parameters that are related to the natural structure of water, the mineralogical composition of the water and the potential treatments that the water undergoes. Thus, the odor of tap water evoked by consumers after stagnation for a certain period of time may be attributable to the dissolution of corrosion products from metal pipes (Proulx *et al*. 2010).

It is reported that this dissolution phenomenon causes the release of trace metal elements such as iron, copper, zinc, nickel or lead depending on the nature of the pipes and plumbing accessories (Lytle and Schock 2000). The presence of these elements in water cannot be a danger in itself when their levels do not exceed their respective limit values decreed by the World Health Organization. However, lead can induce a negative effect, such as saturnism, in the human body even at low amounts, since its physiological role is not known. The sudden change in color of the water observed in Niamey after a rain especially when the winter season sets in would be due to the deposit of dust in the water already treated because the treatment is done in the open from the river water. The formation of the deposit within a vessel containing tap water means that either the settling process is taking place or the water has met, within the pipes, coarse particles which are called upon to settle down at the bottom of the container under the effect of gravity.

Opinion divergence on changes in the tap water quality

If the quality has changed, for some consumers, i.e. 28.00% who think that the quality of the water has remained constant for years, other questioned people, i.e. 28.00%, think that the quality of the distributed water should normally change with the evolution of technology, that is, the quality improves (Figure 5). This does not prevent 24.00% of respondents from saying the opposite, stating that the quality of water only deteriorates

over the years. These are especially those who are in neighborhoods where there are still metal pipes, noticing frequent changes in odor and color in their tap water.

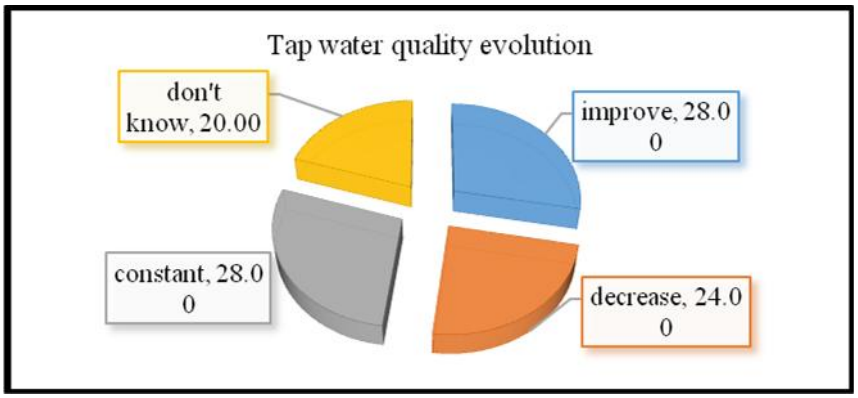

Figure 5: Judgments on changes in the tap water quality (%)

Tap water, deeply consumed without any treatment

"It is consumed directly" without any additional treatment, this is the slogan of most tap water consumers (91.33%) in Niamey (figure 6). According to them, water that has already been treated by a company placed for this purpose no longer needs further treatment in the opinion of confident consumers. In addition, some said that they can do nothing because they don't know the process of such a treatment or not having the means to invest in another treatment. Despite these comments, 02.00% of consumers said they take additional treatments every day and another 06.66% do it frequently. In contrast, in countries such as Canada, Jones *et al.* (2006) report that 49.00% of households report using the filtration device at home for additional treatment of tap water. In addition, in another study 45.00% of households used filtration devices on activated carbon to filter the water from their tap and sometimes (05.00% of households) an advanced filtration device using the ultra-violet lamp, reverse osmosis, ozonation or distillation according to Pintar *et al*. (2009).

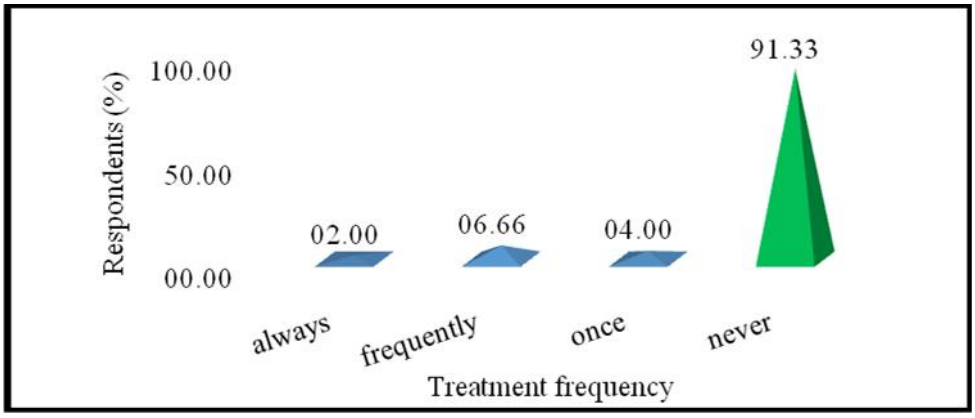

Figure 6: *Treatment of tap water before use*

Perception of sachet water quality

The quality of the bagged water is considered acceptable rather than good, as it has a record of 50.23% of those interviewed (Figure 7). Here too nobody judged the quality of the sachet water to be excellent, against 16.58% which was described as bad. According to them, the fact that the quality is acceptable is mainly related to the packaging and the bagging conditions; bodily and environmental cleanliness. This is what sows the seeds of doubt and a lack of confidence in these sachet waters because they are uncontrolled and most manufacturers are not officially registered. In addition, 67.00% of the 360 consumers interviewed in a community in Jos, Nigeria in 2014 and the majority of 178 residents of Sierra Leone in 2017 rated the bagged water of good quality (Miner *et al*. 2015; Jalloh *et al*. 2018). The judgment on the poor quality of sachet bagged water in Niamey is based mainly on the "presence of particles inside the water bags" and the release of "odor from the plastic bag" when the sachet water is manufactured for a long time.

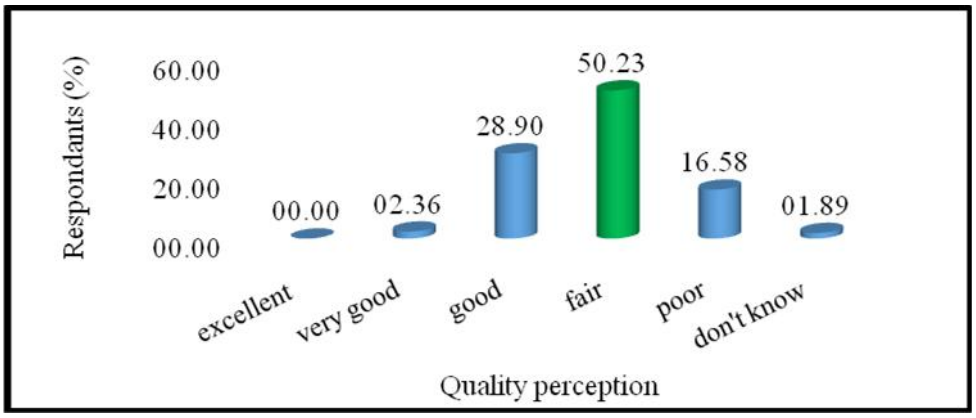

Figure 7: Sachet water's quality perception

Perception of bottled water quality

As shown in Figure 8, more than half of the interviewed water consumers, 55.92%, judged bottled water of good quality because it is "limpid", "clean", "light", "soft" and giving "good satisfaction" for its users. Some 09.47% qualified it as very good quality and others 04.26% qualified it as excellent quality because according to them, it is certified water having undergone extensive treatment, by specialists in well-known factories. In addition, a similar study carried out in three municipalities in South Brazil shows that 93.00% of interviewed consumers perceive good quality bottled water. Because it is water considered naturally healthy and directly packaged while denouncing a questionable quality of tap water which, according to them, requires special treatment to be consumable (De Queiroz *et al*. 2013). The same view was supported by interviewed bottled water's consumers at restaurants in Harare, Zimbabwe (Juba and Tanyanyiwa 2018).

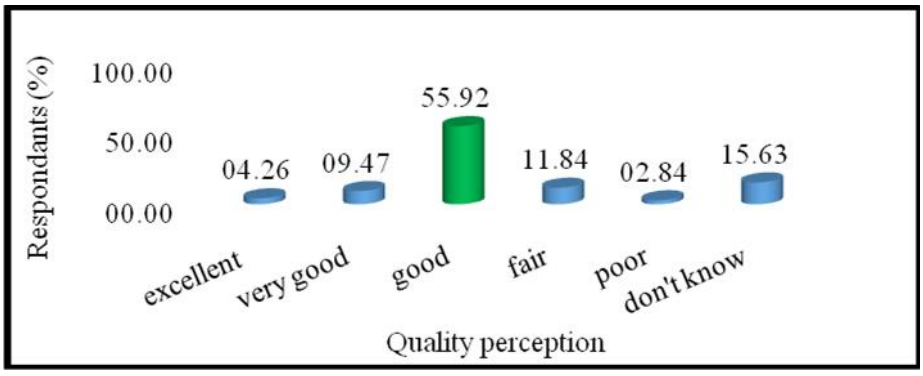

Figure 8: Bottled water's quality perception

Conclusion

Tap water is the main consumed drinking water in Niamey, even though few consumers report "poor quality" due to its appearance, frequent changes in taste, odor and color. The factor favoring this result lies in the accessibility and low price of public water supply. Sachet water is the most occasionally consumed drinking water, ahead of bottled water, despite a lack of confidence on the part of the few consumers. Thus the choice of drinking water in Niamey depends on its availability and its price. The amount of daily consumption varies from 1.5 to more than 7 liters. The judgment of tap water as to its quality is rather acceptable by 45.02% of respondents. The quality of the bagged water is also considered acceptable by 50.23% of these consumers. More than half of these consumers, or 55.92%, judged the bottled water to be of good quality. Some, 09.47% rated it as very good quality and some 04.26% rated it as excellent. These results summarize the water consumption practices in the city of Niamey and can serve as a basic tool for the research and the management of drinking water in this city.

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Conflicts of Interest

The authors stated that they have no competing interests.

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